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Extraction and Utilization of Natural Pigments from Pomegranate Peel

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The quality of food goods and consumer acceptability are significantly influenced by color. Water-soluble phenolic natural colorants called anthocyanins give food products their red, blue, and purple hues. The study aimed to extract and use water-soluble anthocyanins from the peel of pomegranates. Water was used as a solvent to extract anthocyanin to accomplish the goal. The response surface approach was used to improve the extraction conditions at various extraction temperatures and times to maximize anthocyanin production by using antioxidant potential and total phenolic contents as response variables. Anthocyanin was extracted under the ideal extraction conditions (75°C for 140 minutes), and watermelon jam was then made using this extract. The results showed that the optimal extraction conditions produced the highest yield of water-soluble anthocyanin. Pomegranate peel extract showed anthocyanins antioxidant activity using DPPH and ABTS, while total phenolics were also found. The physio-chemical characteristics of watermelon jam enhanced with anthocyanins aqueous extract revealed a titrable acidity of 8.6±0.023% and a maximum vitamin content of 0.93±4.713 mg/ml, while TSS displayed 20.2±0.2Ḥ Brix and pH of 3.1±0.1. according to the judges' sensory evaluation, the watermelon jam enriched with anthocyanin aqueous extract was deemed highly acceptable. The study's findings suggest that water-soluble anthocyanin can be used to create a variety of industrially produced food items.

Keywords: Anthocyanin, anti-oxidant, optimization, watermelon, brix.

INTRODUCTION

Pomegranate is the essential fruit of Northern Africa, it is derived from the word Pomum means apple, Granatus means full of seeds, these words are derived from Latin language, *Pomegranate apple* is its botanical name, and it belongs to family *Lythraceae*. In many subtropical and tropical countries, the pomegranate is most cultivated fruit in the world (Holland *et al*., 2009). The total fruit weight of pomegranate is almost 45-61 percent of the arils in which pomegranate juice is present almost 60-85 per cent and seeds are present almost 15-25. Pomegranate is an important basis of valuable nutritional substances which contains anthocyanins, hydrolysable tannins, organic acid, phenolics and flavanols. Pomegranate fruit is also called superfruit because it has biological activities that are antioxidative, antidiabetic, anti-inflammatory, and antimicrobial (Seeram *et al*., 2006).

Pomegranate peel (PoP), a byproduct of the fruit juice production process, makes up around 30% to 40% of the fruit component. PoP contains a lot of polyphenols, including as tannins, phenolic acids, and flavonoids, particularly anthocyanin. Because of their bioactive components, these peels have a number of functional and nutraceutical benefits, such as lowering blood pressure, oxidative stress, cholesterol, and heart health. PoPs are added to a variety of food applications. It can be added to a variety of goods, including jam, fresh and concentrated fruit juice, biscuits, pasta, cakes, and herbal tea (Ain *et al*., 2023).

Color plays an important role in the processing sector and food production, contributing to the food sensory parameter. It imparts nutritional value, freshness, aesthetic value and safety of a food which directly affect the market value of the colored food product. Food color is any substance which is added to drink or food to modify its sensory parameter and its color. Many people in the food industries use an artificial food color for many reasons like to make food more attractive and appealing, enhance the food color and provide the color to the colorless food but artificial food color may cause hyperactivity in children. With the passage of time consumer

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interest are increased towards the natural food color that carry no risk (Mena *et al*., 2011). Natural water-soluble color are extracted from the vegetables and fruits that play a significant role in the food industries which linked to the human health.

The food coloring industry is particularly interested in anthocyanins because of their capacity to produce vivid hues. Because of their many physiological benefits, anthocyanins have been a part of the human diet for millennia. They have also been used as traditional herbal medicines to cure a variety of ailments, including the common cold, liver difficulties, pyrexia, hypertension, diarrhea, and urinary issues. Materials containing anthocyanins have recently been added to food products; however, more research is needed to show the physiological impacts of these goods (Shipp and Abdel-Aal, 2010). Furthermore, anthocyanins improve food products' sensory appeal by acting as natural colorants that increase consumer acceptability and have health advantages (Mattioli *et al.*, 2020).

Anthocyanin that are used as natural water-soluble food colorants and additives that are more attractive and beneficial for the consumer health in the food industry. In the markets natural water-soluble food color demand is increasing day by day. Anthocyanins natural water-soluble colors are extracted from the peel of the pomegranate having many beneficial properties.

Anthocyanin is derived from two Greek words (Anthos = flower and kyanos = blue). Anthocyanins are naturally occurring molecule that belongs to the flavonoids and phytochemical families. These are present in nuts, wines, tea, fruits, cocoa, cereals, vegetables, red cabbage, black carrot, red radish, and blackcurrant. These pigments are responsible for the colors found in various plant organs such as stem, fruit, root, leaf, flower and tubers. Pomegranate anthocyanins are significant color molecules that can be found in many sectors of tree including the leaves, flowers, and fruits. Secondary metabolites are added to all fruit tissues and are primarily present in the edible section of the fruit, the arils, and the fruit peel (Khoo *et al.*, 2012). Fruit jams are made by mixing an equal amount of fruits and sugar with pectin, which acts as a gelling agent. After that the product is boiled to make a product that is sweet in taste with a lot of sugar and good sensory properties. A natural water soluble pigment that is anthocyanins are added to the jam to enhance its appealing value. Jam making involves thermal process in that change's chemical components and it less the biological activities, to yield a necessary shelf life. Only a few studies have looked at how phenolic chemicals, particularly anthocyanin, alter during the thermal processing of fresh fruits to make jam. The objective of this study was the extraction of anthocyanin from pomegranate peel and evaluate the changes in total phenolics, total anthocyanins, total flavonoids, total anthocyanins and color use into product.

MATERIALS AND METHODS

The research experiments were conducted in post-harvest lab, Department of Food Science and Technology and central lab MNS - University of Agriculture, Multan, Pakistan. Extraction of anthocyanin was done through extraction mixture (0.1% Methanol+HCl) and then extracted anthocyanin was used as a natural food color in watermelon jam. The detail of the material and method obtained during these studies is as under:

***Procurement of material*:** All the chemicals were used in this research for analysis of logical mark and buy from local market of Multan. The pomegranate peel was provided from the horticulture farm or local market of Multan. The material used for this study was provided by the laboratory of MNS-University of Agriculture, Multan.

1. ***Sample preparation*:** Pomegranate peel was collected from the local market of Multan then it was washed, dry and then sorted. Pomegranate peel was dried for 24h at 500in a hot air oven and grind the dried peel by grinder to make powder. Sieved it by sieve no 45 and collected in an airtight jar by the protocol of Panichayupakaranant *et al*. (2010).

***1.1 Extraction of anthocyanin (ΔAg/F.W)*:** Anthocyanins natural water-soluble pigment was extracted as described by the Giusti and wrolstad *et al*. (2001). First pomegranate peel powder extract was prepared. Took 10gm pomegranate peel powder and dissolved in 100ml distilled water. Shaked it in a shaking incubator at 27^0C for 24 hours at 250 rpm. Sieved it from muslin cloth and filtered from the whatman filter no.1. filtrate was prepared and then stored in freezer. Now took 1 g sample of PPE. Add 10ml extraction mixture (0.1% HCl+ Methanol) in the ratio of (15:85) and incubated at 25^0C for 1 hour and finally sample was centrifuged 4000rpm at 4 for 5 minutes. The temperature of 25 °C during centrifugation is used to preserve sample integrity and prevent degradation of sensitive components, while the centrifugation speed of 4000 rpm effectively separates desired particles without causing damage to delicate biological samples. This combination ensures optimal recovery and quality of the extracted materials. Sample plate was read out with the help of Epoch micro plate reader (Bio –Tek instrument, Inc., Winooski, VT, USA). Now took a 100 microliter in 96 micro well plates at 530, 620, 650nm absorbance. The absorbance was determined by using the formula and expressed as change in absorbance /gram.

***1.2 Optimization of extraction condition*:** To maximize the yield and purity of bioactive chemicals from natural sources while maintaining the end product's advantageous qualities, extraction conditions must be optimized. Industries can increase productivity, cut expenses, and improve the general quality of extracts used in food, medicine, and cosmetics by

optimizing variables including temperature, solvent type, and extraction duration.

***Single factor experiment*:** To optimize the azithromycin extract, the first studies were measured using a single-factor analysis. The independent variables for the extraction were temperature (55–75 °C) and time (90–150 minutes) followed by Minneapolis *et al.* (2008).

Multiple factor experiment: Based on the high yield rate of anthocyanin extraction, two parameters were evaluated for the ideal combination of independent variables. The three design variables (time and temperature) utilised in the optimization research (upper, medium, and lower) were centralised in the composite design. X1 and X2 were the design variables, and the answers were a high extraction yield. Equation: The variables were coded according to:

$$Xi = (Xi-Xi)/\Delta Xi$$

Where xi is the coded value (-1, 0, +1) of an independent variable, is the real value of independent variable at the centre point and ΔXi is the step change value.

Verification of model: Optimal compositional model for high yield of anthocyanin extraction was obtained using the predictive equations.

Extraction yield: The extraction yields were measured to the method, followed by Zhang *et al.* (2007).

***1.3 Antioxidant activity*:** Anti-oxidant activity of the anthocyanin extract which was extracted from the pomegranate peel was determined by the DPPH and ABTS method.

***1.3.1 DPPH free radical scavenging (%)*:** The methodology followed was based on the assay described by Bobo-García *et al*. (2014) with modifications, where approximately 1 g of pomegranate peel extract (PPE) was mixed with 5 µL of extraction mixture and then centrifuged at 9,000 rpm for 4 minutes at 4 °C. The supernatant (50 µL) was combined with 5 mL of DPPH solution in test tubes, incubated in the dark for 30 minutes, and the absorbance was measured at 517 nm to assess antioxidant activity.

1.3.2 ABTS Scavenging Activity (%): By Cardador-Martínez (2011), the ABTS scavengers were conducted. By reacting 2.45mM potassium persulfate with 7mM ABTS diammonium salt, an ABTS radical cation was produced. Before being used, this stock solution was allowed to sit at room temperature for 16 hours in the dark. After that, ethanol was added to dilute it until it reached an absorbance of 734 nm. This was diluted in 200 microliters. Twenty microliters of extract and ABTS solution were combined in 96-well plate wells, allowed to react for six minutes, and then the absorbance at 734 nm was measured.

***1.4 Total phenolic contents (mg GAE/100g)*:** Total phenolic compounds from extracts were quantified by the Folin–Ciocalteu method (Singleton *et al*., 1999) changed for 96-well plate assay by Bobo-García *et al*. (2014). Took 1 g sample of PPE. Mix it by adding 5 ml extraction mixture and vortex it. Centrifuged the solution for 3 to 5 minutes at 9000 rpm, 4 degree. Add 300 microliter supernatant and 600 microliter F-C reagent in text tube and vortex. Again, vortex it by adding 800 microliter sodium bicarbonate. Inject 200 microliter solution in ELISA plate and check the absorbance at 765nm.

2. ***Product development*:** The Food and Agriculture Organization's standards for making watermelon jam were followed, although minor alterations were made (FAO, 1997). 500 g of sugar, 2 g of citric acid, and 1 g of pectin were combined with 1 kg of fruit pulp. The mixture was cooked to a jam-like consistency by adding additional sugar and boiling it for an extended period. During the cooking process, usually after the initial ingredients, including watermelon pulp and sugar, have been mixed and heated, the anthocyanin extract (2g) is added to watermelon jam. This guarantees uniform distribution of the anthocyanins throughout the product and permits their complete integration into the jam, improving its color and nutritional profile. After making the jam, it was placed in sterilised glass bottles and kept at room temperature for storage (25-30^{o}C).

Table 1. Recipe for the preparation of watermelon jam.

Ingredients	Amount
Watermelon pulp	1 kg
Sugar	500 g
Citric acid	2 g
Pectin	1 g

Table 2. Recipe for the preparation of supplemented jam.

Ingredients	Amount
Watermelon pulp	1 kg
Sugar	500 g
Citric acid	2 g
Pectin	1 g
Anthocyanin Color extract	2 g

***2.1 Nutritional composition of food product*:** According to the protocol of Morais *et al.* (2017) watermelon jam was followed nutritional composition like, vitamins, minerals.

***2.2.1 Vitamin C determination (mg/ml)*:** The 2, 6-dichlorophenol indophenol titration technique was used to find out how much ascorbic acid contained in the sample. Take 10 g of watermelon jam and 10 ml of distilled water and mix them together. Add 90 ml oxalic acid to the liquid in the volumetric flask, stir well to reach the mark, and quickly filter. Titrate 10 ml of burette filtrate against a 1 ml solution of the dye, 2, 6 dichlorophenol indophenol, in a test tube. It was calculated how much extract was needed to completely remove the dye's hue. Standard ascorbic acid solution was used for the second time in the titration (1 mg pure vitamin per 100 ml).

$$\text{Ascorbic acid} = D1 \times V \times 1 / D \times A \times B$$

***2.2.2 Minerals Determination (mg/L)*:** The mineral contents

of watermelon jam (Ca.Mg.K, Zn.Fe) was analysed with the help of flame photometer and atomic –absorption – spectrophotometer by following the method of Singleton *et al*. (1999).

***2.2 Physio-chemical analysis*:** The prepared jam was analysed for physio -chemical parameter by following the method of Ranganna *et al.* (1997).

***2.2.1 Total soluble solids (Brix %)*:** TSS (Brix %) was determined using a sugar refractometer. Take 10 g sample of watermelon jam and place it in a refractometer and show readings. Take 3 different readings by repeating experiment.

$$TSS = \frac{T1 \times T2 \times T3}{3}$$

***2.2.2 pH*:** pH was determined using a digital pH meter by placing a 2 g sample on it. It will show the readings that will determine may be acid or base or neutral.

***2.2.3 Titratable acidity (%)*:** Titratable acidity (TA) is measured by titration with sodium hydroxide. Take 10 g sample of watermelon jam and add 2-3 drops of phenolphthalein indicator then titrate it with 0.1N NaOH solution. Light pink Color was appeared.

***2.3 Sensory evaluation of Jam*:** Jam was assessed by following parameters: colour, taste, flavour, consistency, aroma and over- all acceptability by the protocol of (Gupta *et al.,* 2016). Watermelon jam was assessed using a 9-point hedonic scale is carried out by untrained panellists. The scale ranged from like extremely (9) to dislike extremely (1).

***2.4 Color measurements*:** As previously mentioned, a Minolta CM-508i colour spectrophotometer (based in Osaka, Japan) was utilized (Zafrilla *et al.,* 2013). Reflective spectroscopy was used to examine a 2.5 mm thick sample on a white background. Values in the L*a*b* format. Using H 5 arctan b*/a* as a reference, we arrived at the hue angle (H). The Minolta Chroma Control S colorimetric data system was used to record and process the data.

***2.5 Statistical Analysis*:** All analysis was carried out and then statistical analysis was done to evaluate and determine the significant difference (Montgomery, 2017). The data found from research was subjected to analysis of variance (ANOVA) by using DESIGN-EXPERT-V11 (Version 6.0.10, Stat-Ease Inc., Minneapolis) software. The values were reported as mean ± standard deviation. Each sample was divided into three replicates for statistical analysis. At a significance level of 0.05, a significant difference was calculated.

RESULTS

Aim of present work was extract the anthocyanin from pomegranate peel by using Methanol and HCL. Utilization of anthocyanin in food product is also the objective of present research. Extraction of anthocyanin was done through extraction mixture (Methanol+HCl) then extracted anthocyanin was identified through ELIZA and then extracted anthocyanin was used as a natural food colour in watermelon jam. After preparing the product nutritional composition was measured. Optimization of extraction condition (time and temperature) was measured. The physicochemical analysis (vitamin C determination, TSS, TA, Minerals determination and pH) and organoleptic (Color, flavour, taste, texture, aroma, consistency and overall acceptability) of prepared final product was analysed.

Anthocyanin, a natural water soluble pigment was isolated from the pomegranate peel. The result showed that anthocyanin concentration of pomegranate peel was 0.0032±0.001% as shown in the Table 1.

Table 1. Anthocyanin content of pomegranate peel extract.

Source	Anthocyanin content
Pomegranate peel extract	0.0032±0.001

Optimization of extraction condition

***Single factor experiment*:** Preliminary experiments were approved before the RSM was used in order to choose the experimental range for independent components and the connected variables in concentration optimization. Time and temperature were shown to be the two most important factors in obtaining the highest yield of anthocyanin extracted from the pomegranate peel in single-factor analysis.

***Effect of temperature on the yield of anthocyanin from pomegranate peel*:** The effect of various temperature concentrations on the yield of anthocyanin extracted from pomegranate peel showed that the yield of anthocyanin increased gradually with increasing temperature up to 75°c after which the yield of anthocyanin remained stable. When distilled water was used as an extractant at a temperature of 75◦C, the highest yield of anthocyanin was discovered. In Fig. 1 there was a definite rise in anthocyanin production with the increases of temperature up to 75°C.

***Effect of time on the yield of anthocyanin from pomegranate peel*:** It was shown that the yield was greatly dependent on the concentration of time and that the growth rate increased with increasing time (Fig.2).

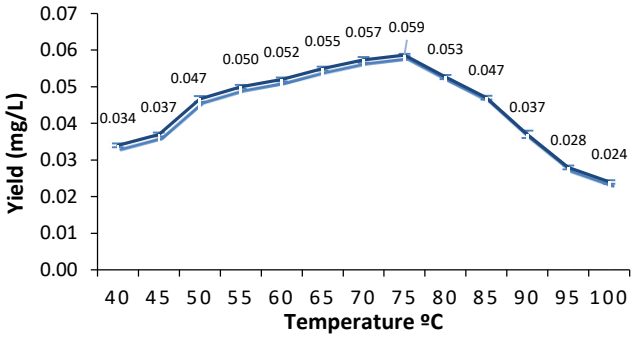

Figure 1. Influence of Temperature on yield of anthocyanin.

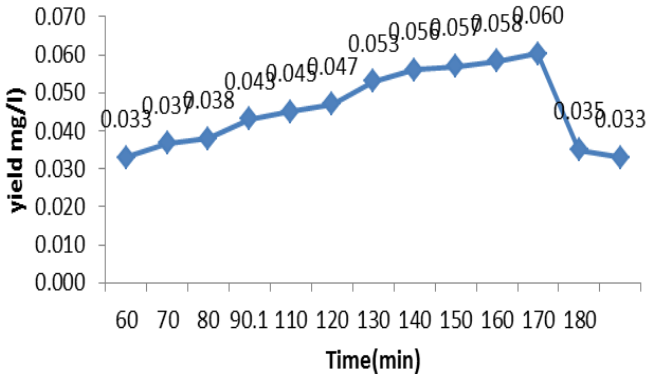

Figure 2. Influence of time on yield of anthocyanin.

***Optimization of anthocyanin extraction condition by response surface methodology (RSM)*:** The RSM was used to observe the impact of Extraction condition (time and temperature) on the anthocyanin extract. The experimental design for this work was formulated to develop an empirical model, studying the interaction of many linked parameters responsible for the extraction of anthocyanin pigment present from a pomegranate peel. Response Surface Methodology (RSM) was selected to optimise the conditions for anthocyanin extraction because it effectively assesses a number of variables and their interactions, enabling improved compound quality and recovery.

Table 2 shows the effect of temperature and extraction time on the current yield of extraction.

Table 2. The independent design variables with coded and uncoded levels and impact on yield rate.

Run	Time (Conc.) (X1)	Temp (Conc.)	Yield
1	140(0)	65(0)	0.061±0.058
2	120(-1)	75(1)	0.052±0.049
3	140(0)	50.85(-1)	0.051±0.048
4	140(0)	79.14(1)	0.050±0.045
5	140(0)	65(0)	0.062±0.059
6	120(-1)	55(-1)	0.039±0.030
7	140(0)	65(0)	0.062±0.058
8	168.2(1)	65(0)	0.049±0.044
9	160(1)	75(1)	0.051±0.048
10	140(0)	65(0	0.059±0.057
11	140(0)	65(0)	0.060±0.056
12	160(1)	55(-1)	0.048±0.044
13	111.71(-1)	65(0)	0.050±0.045

The yield of extract varied with the different concentrations of time and temperature and was in range of 0.061 ± to 0.05mg/L (Table 2). At run 5 and 7, the highest yield rate was observed (0.062±0.058mg/L). The statistical findings demonstrated that the yield of anthocyanin extract was significantly affected by time and temperature.

Response surface plot determines the effect of different variable, two variables temperature and time on the response function (anthocyanin yield) shown in fig.3 shows the effect of time (X1) and temperature (X2) on extraction efficiency. When X1 was fixed as at 65°C, as X2 increased, anthocyanin yield (Y) mounted up, and reached the maximum value, and then reduced. When X2 was fixed, for example, at 140 minutes as X1 increased, anthocyanin yield increased slowly, and reached at maximum value and then reduced below the limit (Atkinson and Donev, 1992).

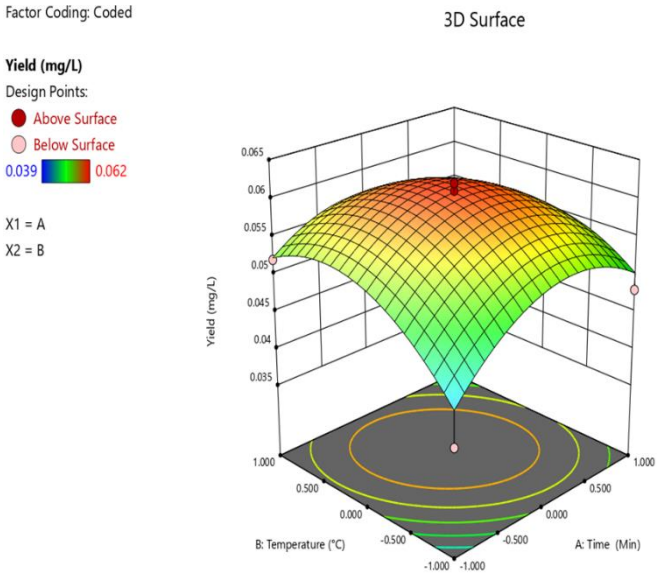

Figure 3. Response surface map showing the effect of independent variables on response variables (yield rate of anthocyanin extract).

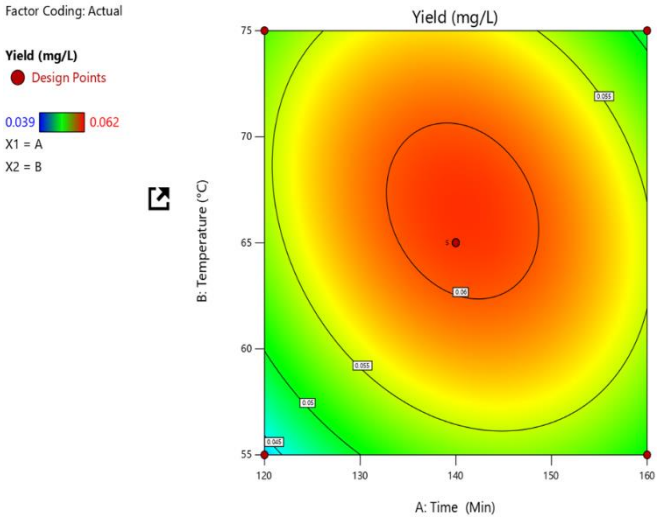

Figure 4. Contour map showing the effect of independent variables on response variables (yield rate of anthocyanin extract).

By overlapping the contours maps of yield rate acquired under various situations using the expert design, the best ranges for relative concentration of time and temperature were predicted. Fig. 4 shows the best ranges for maximizing response variables. The optimum yield rate were estimated for random conditions (time and temperature 140min and 65°c) within the optimum ranges, 0.0608, 0.0523 And 0.0518 respectively. Experimental results (0.061±0.058, 0.052±0.049 and 0.05±0.045, respectively) were obtained under these independent variable conditions, validating the expected anthocyanin extract growth rate values.

The DPPH and ABTS methods were used to assess the antioxidant activity of anthocyanin extract from pomegranate peel. The DPPH method indicated that showed pomegranate peel extracted anthocyanin had 91.54± 0.01 % antioxidant activity while the ABTS methods revealed that pomegranate peel extracted anthocyanin had 78.73 ±3.68% antioxidant activity (Table 3).

Table 3. Mean square table of anti-oxidant activity.

Antioxidant activity	Anthocyanin Extract
DPPH	91.54 ± 0.01
ABTS	78.73 ± 3.68
Total phenolics	88.73 ± 3.78

Nutritional composition of food product

***Vitamin C determination*:** As indicated in Fig. 5 the vitamin C content of watermelon jam with anthocyanin extract was observed to be significant ($p<0.05$). The vitamin C content in watermelon jam, enhances its nutritional profile and antioxidant properties, contributing to consumer health benefits and overall product appeal.

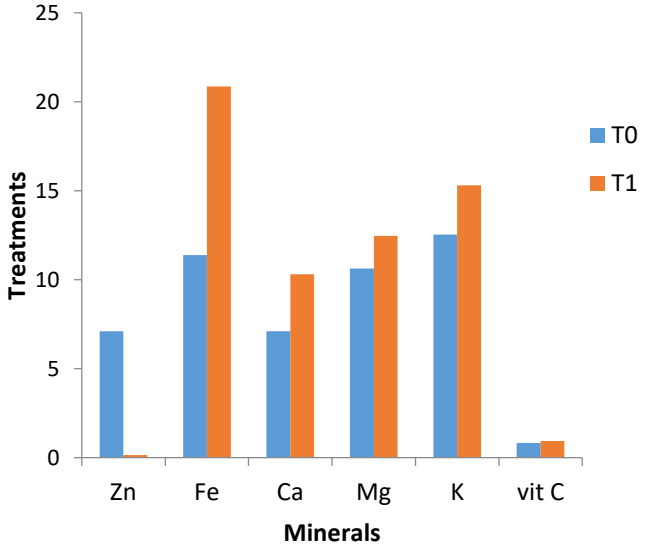

Figure 5. Effect of treatments on minerals content of jam.

***Minerals determination*:** According to the statistical data on supplemented watermelon jam showed that the effect of treatments on mineral content of jam with anthocyanin extract was observed to be significant ($p<0.05$), as shown in the Fig. 5. The contents of minerals (zinc, calcium, potassium, iron magnesium) significantly affected supplemented watermelon jam by enhancing its mineral profile.

According to the findings of the analysis of variance for Mg in watermelon jam, the difference between supplemented jam with anthocyanin extract and without extract results on magnesium was showed to be highly significant ($p<0.04$).

The statistical data on potassium in watermelon jam of potassium content of the jam with anthocyanin extract was observed to be highly significant ($p<0.05$).

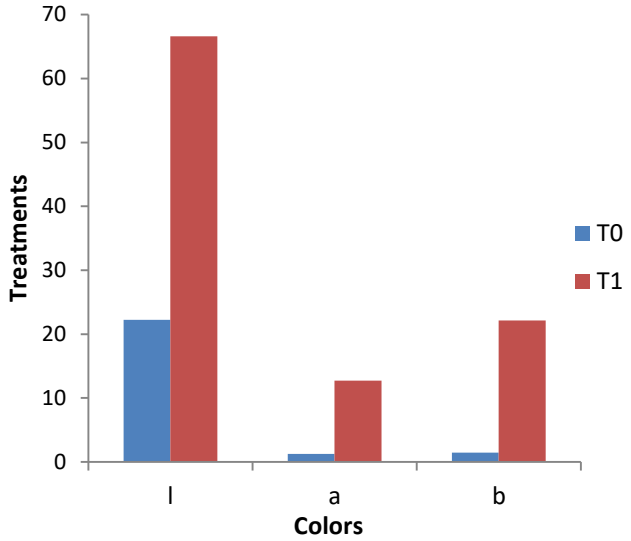

Figure 6. Effect of treatments on color profile of jam

***Physio chemical analysis*:** A sugar refractometer was used to assess the total soluble solids (Brix %). The effect of treatments on supplemented jam physiochemical analysis (TSS, TA, Ph) was observed to be significant.

The pH of the solution is used to determine whether it is the basic or acidic nature of any solution. The range of pH scale is from 1-14, where 7 is neutral, 1 is acidic and 14 is highly basic. The pH meter and pH paper are basically two most used ways for the determination of pH of any food product. The statistical data on the pH of watermelon jam demonstrated that the difference of jam with anthocyanin extract and without extract was observed to be significant ($p <0.05$) shown in the Fig. 7. Additionally, titratable acidity is vital for flavor balance and preservation; maintaining optimal acidity levels ensures the jam's palatability while inhibiting microbial growth, ultimately supporting the quality and shelf-life of the final product.

***Sensory evaluation of jam*:** The sensory evaluation of watermelon jam focuses on assessing key attributes such

as color, aroma, taste, texture, and overall acceptability. Panelists typically use a structured scoring system, like the nine-point hedonic scale, to rate their preferences, which helps determine how well the jam meets consumer expectations. This evaluation is essential for identifying the optimal formulation that enhances sensory appeal while ensuring the product's nutritional benefits, ultimately supporting its market viability and consumer acceptance.

As indicated in the Fig.8 Color is derived from the natural pigments found in fruits and vegetables, many of which change as the plant continue by maturation and ripening. The fat-soluble chlorophylls (green) and carotenoids (yellow, orange, and red) and the water-soluble anthocyanins (red, blue), flavonoids (yellow), and betalains (red) are the primary pigments that impart the color quality (Crisosto *et al*., 2003).

The statistical data regarding color of watermelon jam showed that due to the anthocyanin extract it revealed to be significant ($p<0.04$)

As stated in the Table 4, statistical data demonstrated that the flavour of watermelon jam revealed that results was observed highly significant ($p<0.01$) and shows that watermelon jam with natural water soluble anthocyanin pigment has a good flavour than the jam without anthocyanin pigment and it is acceptable by the consumer.

The results also show that taste of the jam containing anthocyanin pigment was enough to good than the jam having no anthocyanin pigment.

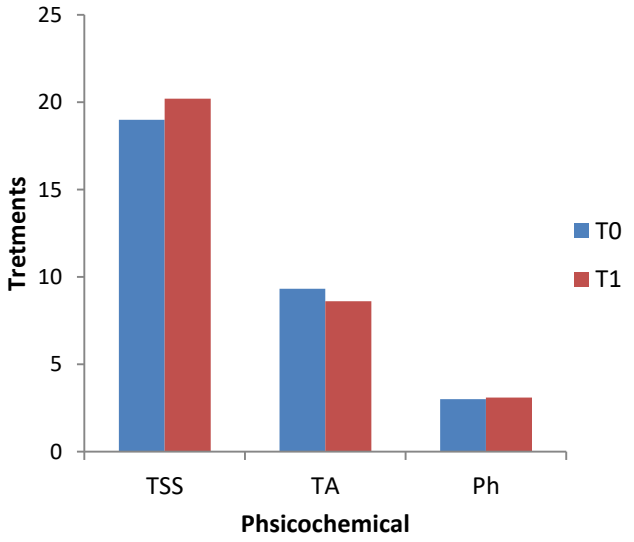

Figure 7. Effect of treatment on physicochemical analysis of the jam

The sense of touch is used to assess the texture whether they picked up by spoon or placed in the mouth or eaten. As indicated in Table 5, statistical data on the texture of watermelon jam demonstrated that texture of the jam was observed highly significant ($p<0.01$).

The effect of treatments on supplemented jam was increased. According to the statistical data, results showed that overall acceptability of watermelon jam showed that results was observed to be highly significant ($p<0.02$).

***Color measurements through calorimeter*:** As indicated in Table 6, statistical data revealed that the effects of anthocyanin color extract and treatments on L* value of jam assessed by colorimeter was observed to be highly significant as shown in the Fig. 6.

The effects of anthocyanin color extract and treatments on a* value of jam evaluated by colorimeter was observed to be highly significant. According to research work it was observed that a* score of jam increased with the passage of time due to the concentration of anthocyanin extract.

The statistical data obtained revealed that the effects of anthocyanin color extract and treatments on b* value of jam evaluated by colorimeter was observed to be highly significant.

According to studies, the b* score of jam increased with the passage of time due to concentration of anthocyanin extract.

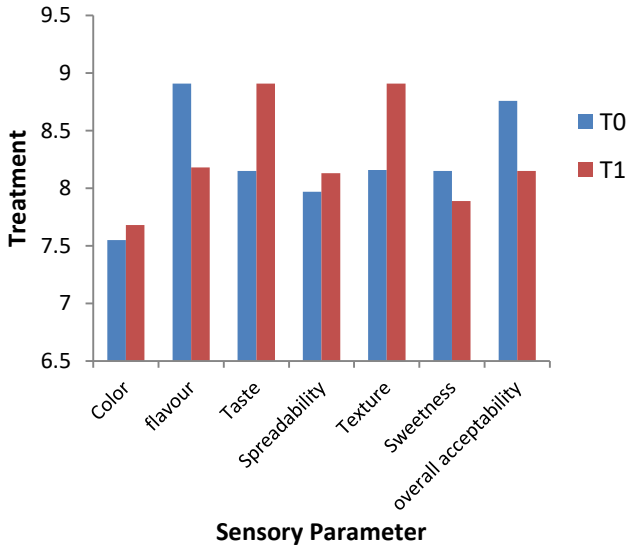

Figure 8. Effect of treatment on sensory parameter of the jam.

DISCUSSION

The findings were supported by Giusti and Wrolstad *et al.* (2001) who worked of extracting anthocyanin from pomegranate peel by using much solvent system. According to their findings, the anthocyanin content of pomegranate peel extract as a possible source of anthocyanin pigment was 0.0029±0.001%. Rababah *et al*. (2005) also reported similar results demonstrated an enhanced yield rate with an increasing temperature concentration up to a specific limit. The extraction yield of anthocyanin was attained at a maximum range of 0.058mg/L, when the concentrated

temperature was 75°c.when the yield concentration was raised above 75°c, however, a minor increase in yield rate was observed. Higher temperature concentrations had no effect on the yield rate of anthocyanin which could be related to the temperature utilization potential of yield. As the temperature increased, anthocyanin yield decreased. These findings were matched those of the previous study (Rababah *et al*., 2005). Similar findings were made by Nicoue *et al*. (2007), who discovered that the yield rate increased as the concentration of time increased up to a certain point. With an anthocyanin yield, this growing trend was only observed for up to 160 minutes. Anthocyanin extraction yield was maximum at 0.058mg/L and had a good extraction yield when the extractant was used at the time of 160 minutes. Following that, the yield remained stable, indicating that an additional increase in time had a detrimental impact on the anthocyanin yield. Fig 2 showed that the effect of concentration time on the extraction yield of anthocyanin extracted from pomegranate peel. The time limit was increased from 160 minutes to 180 minutes. The use of anthocyanin for more than 160 minutes may not result in a rise in a yield rate. The findings were comparable to those of Nicoue *et al*. (2007) also which also found that extending the time reduced the yield of anthocyanin extracted from pomegranate peel.

The findings were similar to those of Silva *et al*. (2004), who discovered the findings of antioxidant activity of DPPH who also found the antioxidant activity of anthocyanin content while working on antioxidant activity of anthocyanin from pomegranate peel. The antioxidant levels of pomegranate peel extract method of ABTS were similar to the findings of Corrales *et al*. (2008). DPPH and ABTS were used to assess the antioxidant activity of anthocyanin isolated from pomegranate peel. The findings matched with the results of the Morais *et al*. (2017) who investigated the acidity of the watermelon jam with anthocyanin extract. The following research showed the zinc content in the supplemented jam was increasing. These results were not matched with the results of Minneapolis *et al*. (2008) which reported that all fruits jam analysed very low content of Zn (0.1-0.3mg/100L). The result of Fe content of supplemented jam of the new work was in close to the result of national institute for health and welfare fineland Naeem *et al.* (2017) which found the highest iron content for its jam. The current study findings are similar to those of Riaz *et al*. (2014) who also observed a highest value of potassium in its jam.

The results are matched with the results of Jaiswal *et al*. (2015) and he also demonstrated that jam with extract is increased because of the cations. Shahnawaz and Shiekh (2011) who conducted that ph of the jam was acidic due to the formation of flavylium cation.

The effect of treatments on Spreadibilty of watermelon jam revealed that results was observed highly significant ($p<0.02$). The current study found that without anthocyanin pigment, the Spreadibilty of jam was reduced and these findings are similar to those of the previous study (Morais *et al*., 2017). The current study found that texture content of jam is reduced without anthocyanin pigment and these results are similar with the results of (Salam *et al*., 2020). The current study found that without anthocyanin pigment, sweetness of jam is reduced and these findings are similar with the results of (Morais *et al*., 2017). The current study found without anthocyanin pigment, overall acceptability scores of jam was reduced without anthocyanin pigment and these results are similar with the results of (Salam *et al*.,2020). Result of color can also be justified with the finding of (Korus *et al*., 2015).

***Conclusion*:** In conclusion, extraction and application of natural pigments extracted from pomegranate peel has vast potential to develop sustainable health-conscious and environment-friendly food products. High bioactivity profile of the pomegranate peel and advancements in extraction technologies render the valuable pigments useful for numerous industrial applications. Harnessing this natural resource to the full could mean that it contributes towards less food waste, facilitates more extensive use of safer, natural additives in consumer products, and encourages environmentally sound practice in both food and cosmetics industries. Continued research and development will surely lead to new applications that are cost-effective, socially acceptable, and economically viable for the industries, but at the same time beneficial to consumers as well.

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